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**Pan**

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(54) **SYSTEM AND METHOD TO CONTROL WIRELESS COMMUNICATIONS**

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(73) Assignee: **Lemko Corporation**, Itasca, IL (US)

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This patent is subject to a terminal disclaimer.

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(51) **Int. Cl.**

| | |
|---|---|
| ***H04W 76/02*** | (2009.01) |
| *H04W 88/10* | (2009.01) |
| *H04W 88/16* | (2009.01) |
| *H04L 29/06* | (2006.01) |

(52) **U.S. Cl.**

CPC ......... ***H04W 76/022*** (2013.01); *H04L 65/1036* (2013.01); *H04W 88/10* (2013.01); *H04W 88/16* (2013.01)

(58) **Field of Classification Search**

CPC ... H04L 12/66; H04L 65/1036; H04W 88/10; H04W 88/16

USPC ........... 709/217, 218, 212; 707/748; 370/352, 370/401; 455/433

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| 4,284,848 | A | 8/1981 | Frost |
| 5,590,175 | A | 12/1996 | Gallant et al. |
| 5,623,495 | A | 4/1997 | Eng et al. |
| 5,623,532 | A | 4/1997 | Houde et al. |
| 5,713,073 | A | 1/1998 | Warsta |
| 5,734,979 | A | 3/1998 | Lu et al. |
| 5,890,064 | A | 3/1999 | Widergen et al. |
| 5,933,784 | A | 8/1999 | Gallagher et al. |

(Continued)

FOREIGN PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| CN | 1427637 | A | 7/2003 |
| EP | 0365885 | A2 | 5/1990 |
| WO | 2007102003 | A1 | 9/2007 |

OTHER PUBLICATIONS

Pan, U.S. Appl. No. 13/309,003; "Providing Communications Using a Distributed Mobile Architecture"; filed Dec. 20, 2011.

(Continued)

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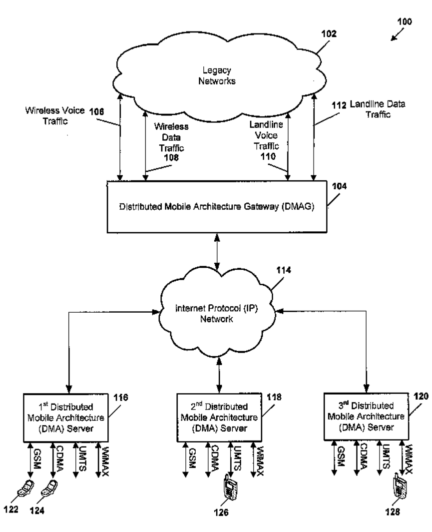
(57) **ABSTRACT**

A method of controlling wireless communications is provided. A call is received from a first mobile device at a base transceiver station (BTS) interface of a first distributed mobile architecture (DMA) server. The call is associated with a destination device. The first DMA server determines that a first distributed mobile architecture gateway (DMAG) supports communication with the destination device based on registration data stored at the first DMA server. Voice information associated with the call is converted to packet data. The packet data is routed to the destination device via the first DMAG.

**20 Claims, 7 Drawing Sheets**



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,991,639 A 11/1999 Rautiola et al.
6,122,499 A 9/2000 Magnusson
6,131,038 A 10/2000 Sekine et al.
6,141,564 A 10/2000 Bruner et al.
6,160,804 A 12/2000 Ahmed et al.
6,411,825 B1 6/2002 Csapo et al.
6,418,308 B1 7/2002 Heinonen et al.
6,421,325 B1 7/2002 Kikinis
6,515,985 B2 2/2003 Shmulevich et al.
6,539,237 B1 3/2003 Sayers et al.
6,542,497 B1 4/2003 Curry et al.
6,549,937 B1 * 4/2003 Auerbach et al. ............ 709/206
6,584,098 B1 6/2003 Dutnall
6,611,533 B1 8/2003 Liao et al.
6,614,784 B1 9/2003 Glitho et al.
6,631,260 B1 10/2003 Carey et al.
6,647,426 B2 11/2003 Mohammed
6,678,155 B1 1/2004 Bresniker
6,694,134 B1 2/2004 Lu et al.
6,697,355 B1 2/2004 Lim
6,704,409 B1 3/2004 Dilip et al.
6,731,932 B1 5/2004 Rune et al.
6,735,184 B1 5/2004 Davidson et al.
6,751,207 B1 6/2004 Lee et al.
6,760,325 B1 7/2004 Hameleers et al.
6,763,226 B1 7/2004 McZeal, Jr.
6,763,233 B2 7/2004 Bharatia
6,791,988 B1 9/2004 Hameleers et al.
6,795,444 B1 9/2004 Vo et al.
6,807,431 B2 10/2004 Sayers et al.
6,807,432 B2 10/2004 Hwang
6,816,706 B1 11/2004 Hohnstein et al.
6,819,652 B1 11/2004 Akhtar et al.
6,829,473 B2 12/2004 Raman et al.
6,831,903 B2 12/2004 Kang
6,839,356 B2 1/2005 Barany et al.
6,859,652 B2 2/2005 Karabinis et al.
6,871,072 B1 3/2005 Meche
6,879,582 B1 4/2005 Dhara et al.
6,879,677 B2 4/2005 Trandal et al.
6,917,813 B2 7/2005 Elizondo
6,937,708 B2 8/2005 Hirose
6,958,983 B2 10/2005 Musikka et al.
6,985,454 B1 1/2006 Wiedeman et al.
7,003,286 B2 * 2/2006 Brown et al. ................ 455/416
7,050,414 B2 5/2006 Lin
7,054,307 B2 5/2006 Papadimitriou et al.
7,054,322 B2 5/2006 D'Annunzio et al.
7,072,650 B2 7/2006 Stanforth
7,117,015 B2 10/2006 Scheinert et al.
7,120,435 B2 10/2006 Usher et al.
7,120,436 B2 10/2006 Kim
7,133,670 B1 11/2006 Moll et al.
7,133,923 B2 11/2006 MeLampy et al.
7,136,651 B2 11/2006 Kalavade
7,154,901 B2 12/2006 Chava et al.
7,158,621 B2 1/2007 Bayne
7,171,216 B1 1/2007 Choksi
7,299,039 B2 11/2007 Lee et al.
7,313,399 B2 12/2007 Rhee et al.
7,324,478 B2 1/2008 Park et al.
7,328,268 B1 2/2008 Foltak et al.
7,345,997 B2 3/2008 Kim
7,346,334 B2 3/2008 Gaeta et al.
7,349,412 B1 3/2008 Jones et al.
7,359,700 B2 4/2008 Swenson et al.
7,383,042 B2 6/2008 Lamb et al.
7,385,947 B2 6/2008 Wu et al.
7,406,069 B2 7/2008 Yashar et al.
7,424,313 B2 9/2008 Ham et al.
7,486,967 B2 2/2009 Pan et al.
7,490,132 B1 * 2/2009 Lyle et al. ..................... 709/207
7,522,632 B2 * 4/2009 La Porta et al. ............... 370/466
7,536,170 B2 5/2009 Goldman et al.
7,539,158 B2 5/2009 Pan
7,548,763 B2 6/2009 Pan
7,552,670 B2 6/2009 Goldman et al.
7,606,594 B2 10/2009 Jesse et al.
7,653,414 B2 1/2010 Pan
7,738,488 B2 6/2010 Marsico et al.
7,760,695 B2 7/2010 Gopalakrishnan et al.
7,787,879 B1 8/2010 Philips et al.
7,840,230 B2 11/2010 Pan
7,855,988 B2 12/2010 Pan
7,856,233 B2 12/2010 Pan
7,979,066 B2 7/2011 Pan
8,018,907 B2 9/2011 Kubler et al.
8,036,158 B2 10/2011 Pan et al.
8,046,420 B2 10/2011 Pan
8,086,536 B2 * 12/2011 Dublish et al. .................. 705/57
8,089,920 B2 1/2012 Pan
8,107,409 B2 1/2012 Pan
8,213,909 B2 7/2012 Lee et al.
8,224,322 B2 7/2012 Pan
8,310,990 B2 11/2012 Pan
8,340,667 B2 12/2012 Pan
8,351,420 B2 * 1/2013 Linkola et al. ................ 370/352
8,359,029 B2 1/2013 Pan
8,676,155 B2 * 3/2014 Fan et al. ...................... 455/406
8,717,009 B2 * 5/2014 Tu ................................ 324/202
2001/0013050 A1 * 8/2001 Shah ............................ 709/202
2001/0036173 A1 11/2001 Shmulevich et al.
2001/0046859 A1 11/2001 Kil
2001/0055298 A1 12/2001 Baker et al.
2002/0009060 A1 1/2002 Gross
2002/0015392 A1 2/2002 Musikka et al.
2002/0016180 A1 2/2002 Derosier et al.
2010/0048208 A9 2/2002 Gunaratnam et al.
2002/0045444 A1 4/2002 Usher et al.
2002/0051518 A1 * 5/2002 Bondy et al. .................... 379/35
2002/0058502 A1 5/2002 Stanforth
2002/0061746 A1 5/2002 Jo et al.
2002/0160772 A1 10/2002 Gailey et al.
2002/0169887 A1 11/2002 MeLampy et al.
2003/0048766 A1 3/2003 D'Annunzio et al.
2003/0063721 A1 4/2003 Hirose
2003/0088698 A1 5/2003 Singh et al.
2003/0092441 A1 5/2003 Taha et al.
2003/0096628 A1 5/2003 Bar-On et al.
2003/0100302 A1 5/2003 Armbruster et al.
2003/0100342 A1 5/2003 Ham et al.
2003/0112748 A1 6/2003 Puppa et al.
2003/0153343 A1 8/2003 Crockett et al.
2003/0154306 A1 8/2003 Perry
2003/0186694 A1 10/2003 Sayers et al.
2003/0198325 A1 10/2003 Bayne
2004/0014466 A1 1/2004 Jesse et al.
2004/0018829 A1 1/2004 Raman et al.
2004/0019539 A1 1/2004 Raman et al.
2004/0156495 A1 * 8/2004 Chava et al. .................. 379/392
2004/0203621 A1 * 10/2004 Brown et al. .............. 455/412.1
2004/0203677 A1 * 10/2004 Brown et al. ................ 455/416
2004/0204097 A1 10/2004 Scheinert et al.
2004/0253949 A1 12/2004 Swensen et al.
2004/0253984 A1 12/2004 Csapo et al.
2004/0259556 A1 12/2004 Czys
2005/0044152 A1 * 2/2005 Hardy et al. .................. 709/206
2005/0064922 A1 3/2005 Owens et al.
2005/0070278 A1 3/2005 Jiang
2005/0075106 A1 4/2005 Jiang
2005/0091392 A1 4/2005 Gesswein et al.
2005/0176413 A1 8/2005 Lee et al.
2005/0220054 A1 10/2005 Meier et al.
2005/0249176 A1 11/2005 O'Neil et al.
2005/0250491 A1 * 11/2005 Roy ............................. 455/428
2006/0026252 A1 * 2/2006 Caspi et al. ................... 709/207
2006/0046714 A1 * 3/2006 Kalavade ...................... 455/428
2006/0046760 A1 3/2006 Bertino et al.
2006/0047836 A1 3/2006 Rao et al.
2006/0052113 A1 * 3/2006 Ophir et al. ................ 455/456.1
2006/0063544 A1 3/2006 Zhao et al.
2006/0098661 A1 5/2006 Pan
2006/0114934 A1 6/2006 Shin et al.
2006/0141984 A1 6/2006 Taglienti et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS


| | | | | |
|---|---|---|---|---|
| 2006/0142011 | A1 | 6/2006 | Kallio | |
| 2006/0148465 | A1 | 7/2006 | Perdomo et al. | |
| 2006/0159039 | A1 | 7/2006 | Jung et al. | |
| 2006/0203746 | A1 | 9/2006 | Maggenti et al. | |
| 2006/0217121 | A1 | 9/2006 | Soliman et al. | |
| 2006/0221912 | A1 | 10/2006 | Olivier et al. | |
| 2006/0234747 | A1 | 10/2006 | Pan | |
| 2006/0234774 | A1 | 10/2006 | Pan et al. | |
| 2006/0258358 | A1 | 11/2006 | Kallio | |
| 2007/0008968 | A1 | 1/2007 | Baker et al. | |
| 2007/0010245 | A1 | 1/2007 | Levitan | |
| 2007/0021097 | A1 | 1/2007 | Gaeta et al. | |
| 2007/0021118 | A1 | 1/2007 | Ophir | |
| 2007/0060124 | A1* | 3/2007 | Kalavade | 455/433 |
| 2007/0076697 | A1* | 4/2007 | Huotari et al. | 370/352 |
| 2007/0082684 | A1 | 4/2007 | Rozenstrauch et al. | |
| 2007/0087738 | A1 | 4/2007 | Melkesetian | |
| 2007/0127423 | A1 | 6/2007 | Ho | |
| 2007/0147598 | A1 | 6/2007 | Somes et al. | |
| 2007/0197215 | A1 | 8/2007 | Ben-Yehuda et al. | |
| 2007/0202847 | A1 | 8/2007 | Pan | |
| 2007/0213075 | A1 | 9/2007 | Jiang | |
| 2007/0230352 | A1 | 10/2007 | Kokku et al. | |
| 2007/0232267 | A1 | 10/2007 | Pan | |
| 2007/0232304 | A1 | 10/2007 | Goldman et al. | |
| 2007/0234892 | A1 | 10/2007 | Goldman et al. | |
| 2007/0243891 | A1* | 10/2007 | Civanlar et al. | 455/466 |
| 2007/0271606 | A1* | 11/2007 | Amann et al. | 726/15 |
| 2007/0287452 | A1 | 12/2007 | Pan | |
| 2007/0291910 | A1* | 12/2007 | Bucchieri et al. | 379/88.06 |
| 2007/0293216 | A1* | 12/2007 | Jiang | 455/433 |
| 2008/0013531 | A1 | 1/2008 | Elliott et al. | |
| 2008/0039144 | A1 | 2/2008 | Pan et al. | |
| 2008/0080438 | A1 | 4/2008 | Gopalakrishnan et al. | |
| 2008/0101314 | A1 | 5/2008 | Bachmutsky | |
| 2008/0101410 | A1* | 5/2008 | Barkley et al. | 370/473 |
| 2008/0134295 | A1* | 6/2008 | Bailey et al. | 726/4 |
| 2008/0146158 | A1 | 6/2008 | Pan et al. | |
| 2008/0160997 | A1 | 7/2008 | Kim | |
| 2008/0168523 | A1* | 7/2008 | Ansari et al. | 725/131 |
| 2008/0244014 | A1* | 10/2008 | Britton et al. | 709/206 |
| 2008/0261580 | A1 | 10/2008 | Wallentin et al. | |
| 2009/0003269 | A1 | 1/2009 | Kumazawa et al. | |
| 2009/0022155 | A1 | 1/2009 | Rosenberg et al. | |
| 2009/0031244 | A1* | 1/2009 | Brezina et al. | 715/781 |
| 2009/0067441 | A1* | 3/2009 | Ansari et al. | 370/401 |
| 2009/0156213 | A1* | 6/2009 | Spinelli et al. | 455/436 |
| 2009/0186626 | A1 | 7/2009 | Raghothaman | |
| 2009/0215449 | A1 | 8/2009 | Avner | |
| 2009/0227230 | A1 | 9/2009 | Camilleri et al. | |
| 2009/0227235 | A1 | 9/2009 | Pan | |
| 2009/0228555 | A1* | 9/2009 | Joviak et al. | 709/205 |
| 2009/0270097 | A1* | 10/2009 | Gallagher et al. | 455/435.1 |
| 2009/0271491 | A1 | 10/2009 | Pan | |
| 2009/0292785 | A1* | 11/2009 | Leedberg et al. | 709/206 |
| 2009/0325584 | A1 | 12/2009 | Pan | |
| 2009/0327819 | A1 | 12/2009 | Pan | |
| 2010/0008306 | A1 | 1/2010 | Pan | |
| 2010/0008369 | A1 | 1/2010 | Pan | |
| 2010/0048197 | A1 | 2/2010 | Jiang | |
| 2010/0057485 | A1 | 3/2010 | Luft | |
| 2010/0057732 | A1* | 3/2010 | O'Sullivan et al. | 707/6 |
| 2010/0075668 | A1 | 3/2010 | Pan | |
| 2010/0080214 | A1* | 4/2010 | Li et al. | 370/352 |
| 2010/0094878 | A1* | 4/2010 | Soroca et al. | 707/748 |
| 2010/0199340 | A1* | 8/2010 | Jonas et al. | 726/8 |
| 2010/0217809 | A1* | 8/2010 | Vymenets et al. | 709/206 |
| 2010/0217837 | A1* | 8/2010 | Ansari et al. | 709/218 |
| 2011/0059740 | A1 | 3/2011 | Pan | |
| 2011/0060853 | A1 | 3/2011 | Pan | |
| 2011/0223921 | A1 | 9/2011 | Pan et al. | |
| 2011/0320576 | A1* | 12/2011 | Lauer et al. | 709/220 |
| 2012/0002607 | A1 | 1/2012 | Pan | |
| 2012/0020293 | A1* | 1/2012 | Nix et al. | 370/328 |
| 2012/0044908 | A1* | 2/2012 | Spinelli et al. | 370/331 |
| 2012/0094659 | A1 | 4/2012 | Pan | |
| 2012/0106454 | A1 | 5/2012 | Pan | |
| 2012/0224586 | A1 | 9/2012 | Nag et al. | |
| 2012/0252444 | A1 | 10/2012 | Pan | |
| 2012/0324041 | A1* | 12/2012 | Gerber et al. | 709/217 |
| 2013/0039279 | A1 | 2/2013 | Pan | |
| 2013/0130677 | A1 | 5/2013 | Pan | |
| 2013/0148578 | A1 | 6/2013 | Pan | |
| 2015/0081812 | A1* | 3/2015 | Davies et al. | 709/206 |


OTHER PUBLICATIONS


B.G. Evans and K. Baughan; "Visions of 4G"; Electronics & Communication Engineering Journal; Dec. 2000; pp. 293-303.

Shirshanka Das, Alok Nandan & Giovanni Pau (University of CA, Los Angeles, CA, USA); "SPAWN: A Swarming Protocol for Vehicular Ad-Hoc Wireless Networks"; VANET'04, Oct. 1, 2004, Philadelphia, PA, USA; ACM 1-58113-922-5/04/0010; 2 pgs.

Yu-Chee Tseng, Chia-Ching Shen (National Chiao Tung University) & Wen-Tsuen Chen (National Tsing Hua University); "Integrating Mobile IP with AD Hoc Networks"; IEEE Computer Society; 0018-9162/03; 2003 IEEE; May 2003; pp. 48-55.

Halim Yanikomeroglu, David D. Falconer & Van M. Sreng; "Coverage Enhancement Through Two-Hop Peer-to-Peer Relaying in Cellular Radio Networks"; Broadband Communications and Wireless Systems (BCWS) Centre Department of Systems & Computer Engineering, Carleton University, Ottawa, Canada; WWRF Meeting #7, Eindhoven, the Netherlands, Dec. 3-4, 2002, WG4: Spectrum, New Air Interfaces and Ad-Hoc Networking Multi-Hop Wireless Systems; 10 pages.

Bur Goode; "Voice Over Internet Protocol (VoIP)"; 0018-9219/02 2002 IEEE; Proceedings of the IEEE; vol. 90, No. 9, Sep. 2002; pp. 1495-1517.

Kyung-Hyu Lee, Kyu-Ok Lee & Kwon-Chul Park (Network Research Laboratory ETRI Korea) Jong-Ok Lee and Yoon-Hak Bang (Network Planning Team KT Korea); "Architecture to be Deployed on Strategies of Next-Generation Networks"; 0-7803-7802-4/03 2003 IEEE; pp. 819-822.

Wolfgang Kellerer, Christian Bettstetter, Christian Schwingenschlögl & Peter Sties (Technische Universität München) Karl-Ernst Steinberg (BMW) & Hans-Jörg Vögel (the Fantastic Corp); "(Auto) Mobile Communication in a Heterogeneous and Converged World"; IEEE Personal Communications; Dec. 2001; 1070-9916/01; 2001 IEEE pp. 41-47.

Nilanjan Banerjee & Sajal K. Das (University of Texas, Arlington) & Arup Acharya (IBM T.J. Watson Research Center) "Peer-to-peer SIP-based Services over Wireless Ad Hoc Networks"; BROADWIM: Broadband Wireless Multimedia Workshop; Oct. 29, 2004—broadnets.org; *This work was supported by NSF under the ORBIT testbed project, grant # NSF NRT Project #ANI-0335244 and by NSF ITR grant IIS-0326505; 8 pages.

Hung-Yu Wei (Columbia University) & Richard D. Gitlin (NEC Laboratories America); "Two-Hop-Relay Architecture for Next-Generation WWAN/WLAN Integration"; 4G Mobile Communications: Toward Open Wireless Architecture; 1536-1284/04 2004 IEEE; IEEE Wireless Communications; Apr. 2004; pp. 2-9.

Wolfgang Kellerer (LKN, Munich University of Technology), Hans-Jörg Vögel (the Fantastic Corp.) & Karl-Ernst Steinberg (BMW); "A Communication Gateway for Infrastructure Independent Wireless Access"; IEEE Communications Magazine; Mar. 2002; vol. 9; No. 3; 6 pages.

Willie W. Lu & Jenny Hu (U.S. Center for Wireless Communications, Stanford University, CA); "Open Wireless Architecture—The Core to 4G Mobile Communications"; China Communications; Apr. 2006; pp. 32-39.

Ralf Pabst, Bernard H. Walke & Daniel C. Schultz (RWTH Aachen University) Patrick Herhold & Gerhard P. Fettweis (Technical University of Dresden) Halim Yanikomeroglu & David D. Falconer (Carleton University) Sayandev Mukherjee & Harish Viswanathan (Lucent Technologies) Matthias Lott & Wolfgang Zirwas (Siemens ICM) Mischa Dohler & Hamid Aghvami (Kings College); "Relay-Based Deployment Concepts for Wireless and Mobile Broadband Radio"; 0163-6804/04; 2004 IEEE; IEEE Communications Magazine; Sep. 2004; pp. 80-89.

(56) **References Cited**

OTHER PUBLICATIONS

Simone Frattasi, Hanane Fathi, Frank H.P. Fitzek & Ramjee Prasad (Aalborg University) Marcos D. Katz (Samsung Electronics); "Defining 4G Technology from the User's Perspective"; IEEE Network; Jan./Feb. 2006; 0890-8044/06; 2006 IEEE; pp. 35-41.

Ian F. Akyildiz (Broadband and Wireless Networking BWN Lab, Georgia Institute of Technology) Xudong Wang & Weilin Wang (Kiyon, Inc. La Jolla, CA); "Wireless Mesh Networks: A Survey"; Computer Networks 47; Jan. 1, 2005; pp. 445-487; 1389-1286 2004 Elsevier B.V.

Brian Woerner (Virginia Tech, Blacksburg, VA) & Mostofa Howlader (University of Tennessee, Knoxville, TN); "Research Directions for Fourth Generation Wireless"; Proceedings of the 10th IEEE International Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE 2001); Jun. 20-22, 2001; Cambridge, MA, USA; IEEE Computer Society 2001; ISBN 0-7695-1269-0; 2 pages.

"Framework and Overall Objectives of the Future Development of IMT-2000 and Systems Beyond IMT-2000"; International Telecommunication Union; ITU-R Radiocommunication Sector of ITU; Recommendation ITU-R M.1645 (Jun. 2003); M Series; Mobile, Radiodetermination, Amateur and Related Satellite Services; 26 pages.

Hoffpauir et al., United States Statutory Invention Registration No. H1,918 published Nov. 7, 2000, 19 pages.

Notice to File Corrected Application Papers for U.S. Appl. No. 12/108,209 received from the United States Patent and Trademark Office (USPTO) dated May 9, 2008, 2 pages.

Non-Final Ofice Action for U.S. Appl. No. 12/108,209 received from the United States Patent and Trademark Office (USPTO) dated Dec. 23, 2010, 16 pages.

Notice of Allowance and Fee(s) Due for U.S. Appl. No. 12/108,209 received from the United States Patent and Trademark Office (USPTO) dated Jun. 23, 2011, 17 pages.

Extended European Search Report for European Application No. 05801092.7-1525/1810465, PCT/US05/035648 mailed Jan. 31, 2011, 72 pages.

First Examination Report for Indian Application No. 469/MUMNP/2007, dated Mar. 30, 2013, 4 pages.

International Report on Patentability and Written Opinion of the International Search Authority for International Application No. PCT/US05/35648 from the International Searching Authority, mailed on Aug. 24, 2006, 8 pages.

International Search Report and Written Opinion of the International Search Authority for International Application No. PCT/US09/045951 from the International Searching Authority, mailed on Dec. 30, 2009, 8 pages.

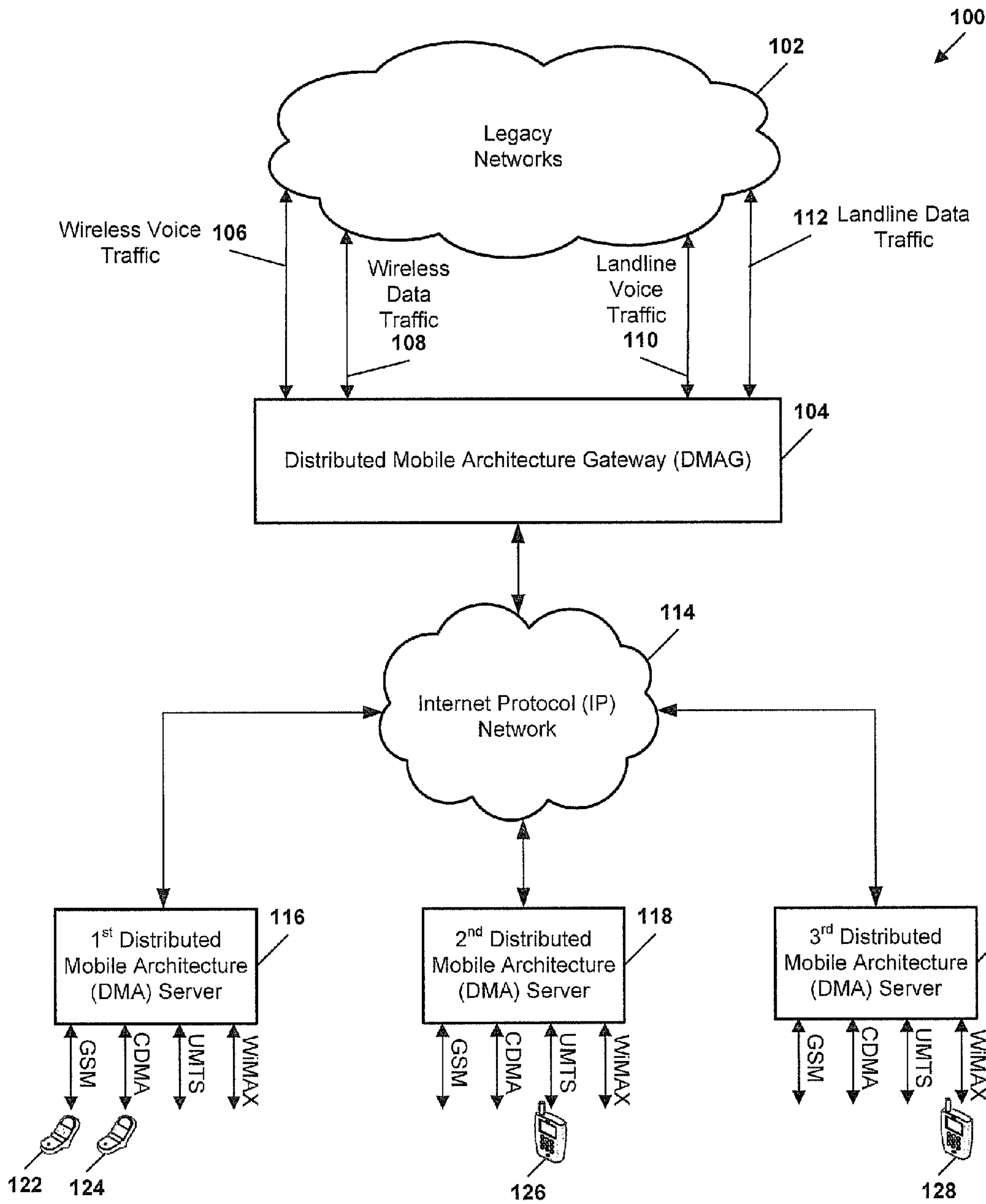
International Search Report and Written Opinion of the International Search Authority for International Application No. PCT/US09/045957 from the International Searching Authority, mailed on Jan. 14, 2010, 8 pages.

International Search Report and Written Opinion of the International Search Authority for International Application No. PCT/US09/045968 from the International Searching Authority, mailed on Jan. 21, 2010, 9 pages.

International Search Report and Written Opinion of the International Search Authority for International Application No. PCT/US09/045973 from the International Searching Authority, mailed on Jan. 18, 2010, 10 pages.

Yu, W. et al., Abstract of "Reverse Link Capacity Analysis on Distributed Wireless Communication System", Journal of Beijing University of Posts and Telecommunications, 2004, Issue 3, Retrieved from <http://en.cnki.com.cn/article_en/CJFDTOTAL-BJYD200403020.htm>, 3 pages.

* cited by examiner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Wireless Data Traffic 108
Landline Voice Traffic 110
112 Landline Data Traffic
104
Distributed Mobile Architecture Gateway (DMAG)
114
Internet Protocol (IP) Network
1st Distributed Mobile Architecture (DMA) Server
116
2nd Distributed Mobile Architecture (DMA) Server
118
3rd Distributed Mobile Architecture (DMA) Server
120
GSM
CDMA
UMTS
WiMAX
122
124
126
128

FIG. 1

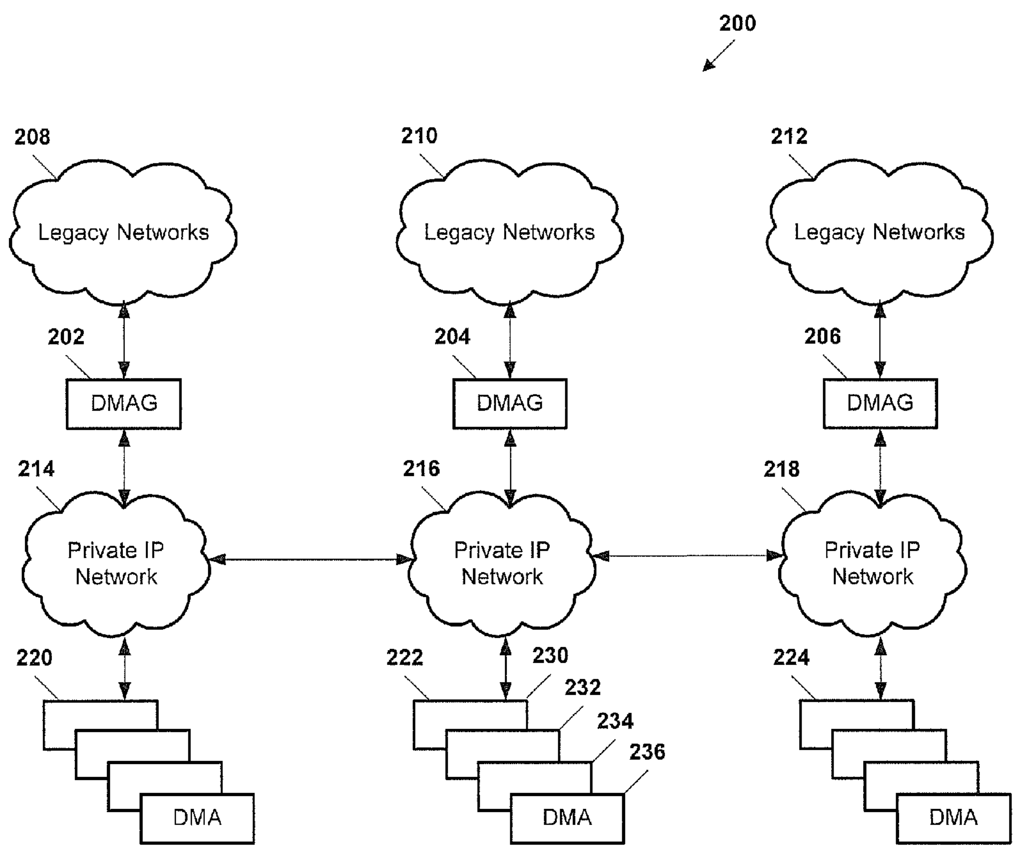
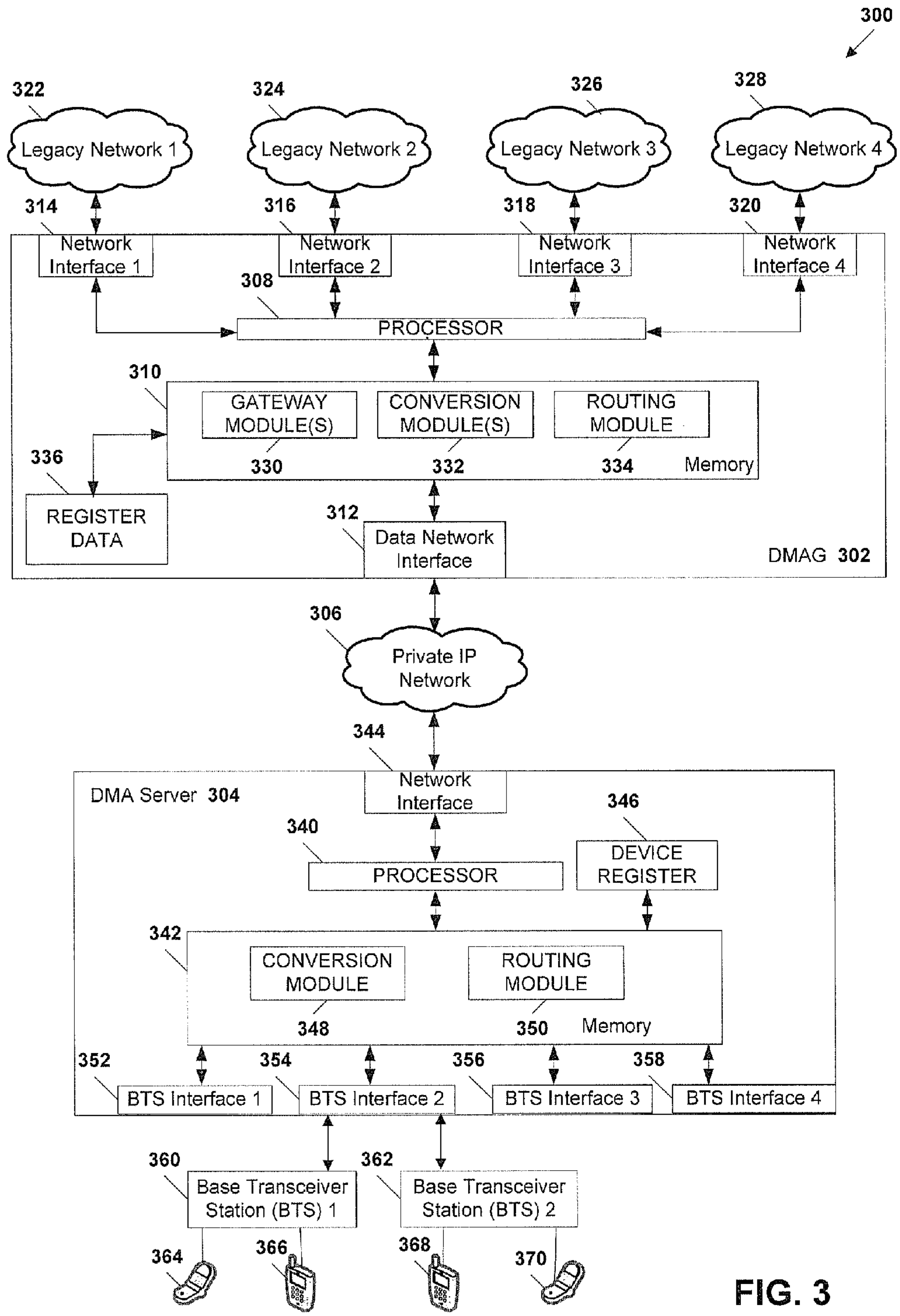

200
208
Legacy Networks
210
Legacy Networks
212
Legacy Networks
202
DMAG
204
DMAG
206
DMAG
214
Private IP Network
216
Private IP Network
218
Private IP Network
220
DMA
222
230
232
234
236
DMA
224
DMA

FIG. 2



300
322
Legacy Network 1
324
Legacy Network 2
326
Legacy Network 3
328
Legacy Network 4
314
Network Interface 1
316
Network Interface 2
318
Network Interface 3
320
Network Interface 4
308
PROCESSOR
310
GATEWAY MODULE(S)
CONVERSION MODULE(S)
ROUTING MODULE
330
332
334
Memory
336
REGISTER DATA
312
Data Network Interface
DMAG 302
306
Private IP Network
344
Network Interface
DMA Server 304
340
PROCESSOR
346
DEVICE REGISTER
342
CONVERSION MODULE
ROUTING MODULE
348
350
Memory
352
BTS Interface 1
354
BTS Interface 2
356
BTS Interface 3
358
BTS Interface 4
360
Base Transceiver Station (BTS) 1
362
Base Transceiver Station (BTS) 2
364
366
368
370


FIG. 3

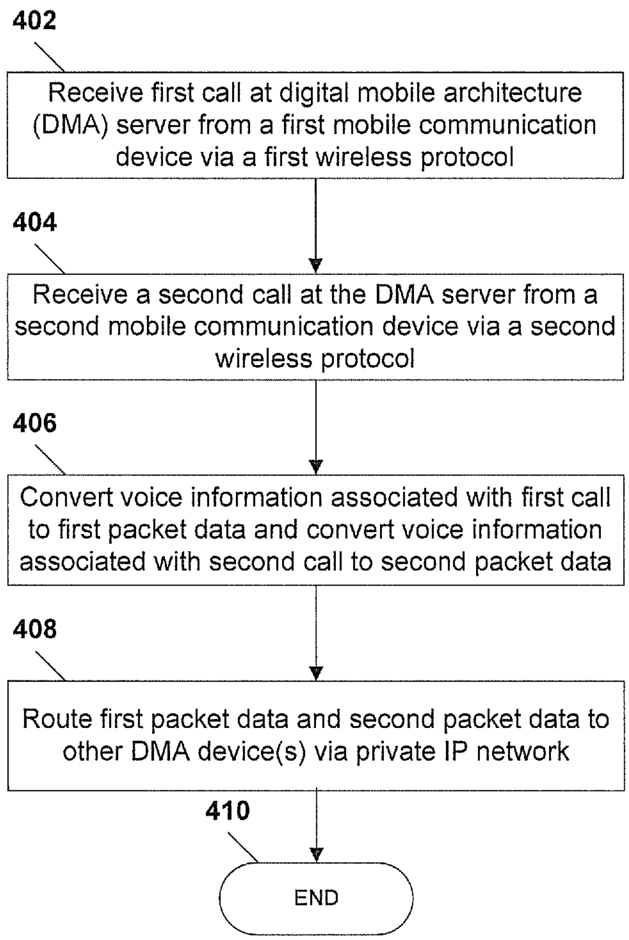

402
Receive first call at digital mobile architecture (DMA) server from a first mobile communication device via a first wireless protocol
404
Receive a second call at the DMA server from a second mobile communication device via a second wireless protocol
406
Convert voice information associated with first call to first packet data and convert voice information associated with second call to second packet data
408
Route first packet data and second packet data to other DMA device(s) via private IP network
410
END

FIG. 4

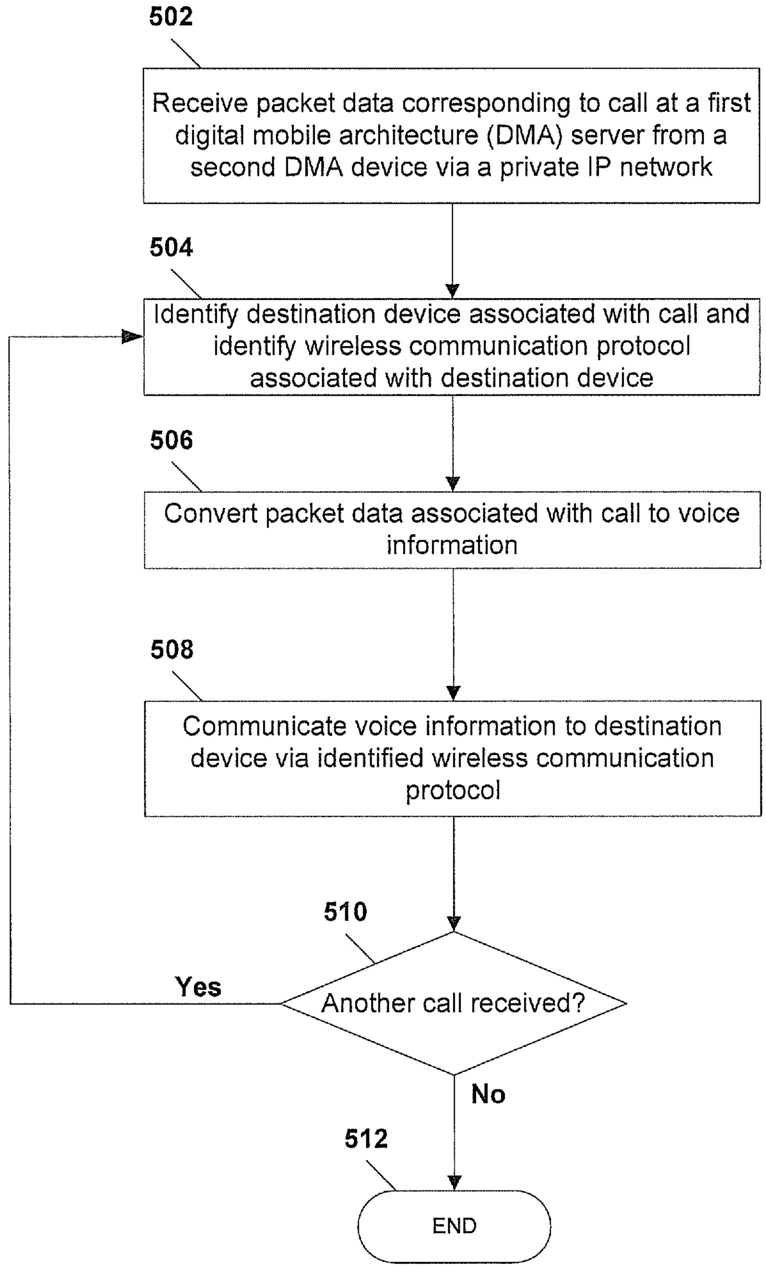

502
Receive packet data corresponding to call at a first digital mobile architecture (DMA) server from a second DMA device via a private IP network
504
Identify destination device associated with call and identify wireless communication protocol associated with destination device
506
Convert packet data associated with call to voice information
508
Communicate voice information to destination device via identified wireless communication protocol
510
Another call received?
Yes
No
512
END

FIG. 5

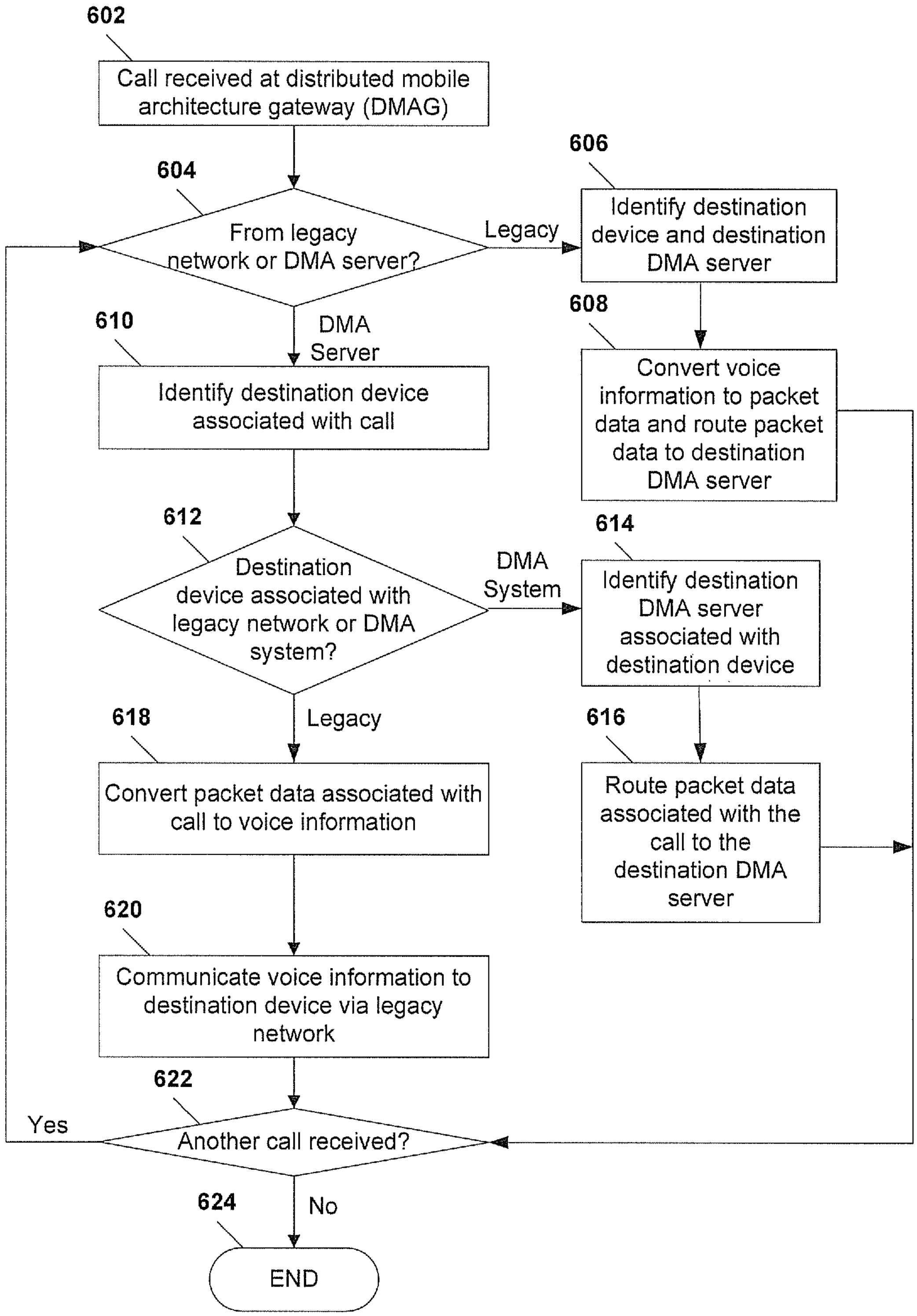

602
Call received at distributed mobile architecture gateway (DMAG)
604
From legacy network or DMA server?
Legacy
606
Identify destination device and destination DMA server
608
Convert voice information to packet data and route packet data to destination DMA server
DMA Server
610
Identify destination device associated with call
612
Destination device associated with legacy network or DMA system?
DMA System
614
Identify destination DMA server associated with destination device
Legacy
618
Convert packet data associated with call to voice information
616
Route packet data associated with the call to the destination DMA server
620
Communicate voice information to destination device via legacy network
622
Another call received?
Yes
624
No
END

FIG. 6

700

| | 708 | 710 | 712 | 714 | 716 | 718 |
|---|---|---|---|---|---|---|
| | DMA Node Register | DMA Node HLR | DMA Node VLR | Visitor DMA Node Register | Visitor DMA Node HLR | Visitor DMA Node VLR |
| 702 | Home DMA Server Register | HLR of each DMA Server | VLR of each DMA server | Visitor DMA server Register | HLR of each visitor DMA server | VLR of each Visitor DMA server |
| 704 | DMA server Register of 2nd DMAG | HLR of each DMA server of 2nd DMAG | VLR of each DMA server of 2nd DMAG | Visitor DMA server Register of 2nd DMAG | HLR of each Visitor DMA server of 2nd DMAG | VLR of each Visitor DMA server of 2nd DMAG |
| 706 | DMA server Register of 3rd DMAG | HLR of each DMA server of 3rd DMAG | VLR of each DMA server of 3rd DMAG | Visitor DMA server Register of 3rd DMAG | HLR of each Visitor DMA server of 3rd DMAG | VLR of each Visitor DMA server of 3rd DMAG |

720

| | 728 | 730 | 732 | 734 | 736 | 738 |
|---|---|---|---|---|---|---|
| | DMA Node Register | DMA Node HLR | DMA Node VLR | Visitor DMA Node Register | Visitor DMA Node HLR | Visitor DMA Node VLR |
| 722 | Home DMA Server Register | HLR of each DMA Server | VLR of each DMA server | Visitor DMA server Register | HLR of each visitor DMA server | VLR of each Visitor DMA server |
| 724 | DMA server Register of 1st DMAG | HLR of each DMA server of 1st DMAG | VLR of each DMA server of 1st DMAG | Visitor DMA server Register of 1st DMAG | HLR of each Visitor DMA server of 1st DMAG | VLR of each Visitor DMA server of 1st DMAG |
| 726 | DMA server Register of 3rd DMAG | HLR of each DMA server of 3rd DMAG | VLR of each DMA server of 3rd DMAG | Visitor DMA server Register of 3rd DMAG | HLR of each Visitor DMA server of 3rd DMAG | VLR of each Visitor DMA server of 3rd DMAG |

FIG. 7

# SYSTEM AND METHOD TO CONTROL WIRELESS COMMUNICATIONS

## CLAIM OF PRIORITY

The present application claims priority from and is a continuation of patent application Ser. No. 12/108,209 filed on Apr. 23, 2008 and entitled "SYSTEM AND METHOD TO CONTROL WIRELESS COMMUNICATIONS," the contents of which are expressly incorporated herein by reference in their entirety.

## FIELD OF THE DISCLOSURE

The present disclosure relates generally to controlling wireless communications.

## BACKGROUND

Access to telephony service is important for rural and isolated communities. However, while urban areas typically offer a variety of telephony services, such as landline, wireless, and broadband, rural areas often have limited or no telephony services. For example, many Asian countries have a penetration of four (4) telephone lines per one-hundred (100) inhabitants in urban areas, but a penetration of less than 0.2 per one-hundred (100) in rural areas. Access to telephony service is non-existent in some African countries and in some parts of Latin America.

Current telephone systems are expensive to deploy. For example, a typical cellular system requires a mobile switching center (MSC), a base station controller (BSC), and a home location register/visitor location register (HLR/VLR), collectively costing over two million dollars. Moreover, such a system requires a minimum of ten thousand users in order to be economically viable. Many rural areas lack a population large enough to support the installation of such a system. In addition, the environmental conditions in which the equipment, e.g., the MSC, BSC, and HLR/VLR, operates may be extremely harsh or cost-prohibitive to deploy. Alternatives, such as landline systems, are also expensive to deploy and face even more environmental restrictions.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a first embodiment of a system to control wireless communications;

FIG. **2** is a block diagram of a second embodiment of a system to control wireless communications;

FIG. **3** is a block diagram of a third embodiment of a system to control wireless communications;

FIG. **4** is a flow diagram of a first method of controlling wireless communications;

FIG. **5** is a flow diagram of a second method of controlling wireless communications;

FIG. **6** is a flow diagram of a third method of controlling wireless communications; and

FIG. **7** is an illustrative embodiment of data associated with a distributed mobile architecture gateway (DMAG).

## DETAILED DESCRIPTION OF THE DRAWINGS

A method includes receiving a call from a first mobile device at a base transceiver station (BTS) interface of a first distributed mobile architecture (DMA) server. The call is associated with a destination device. The method includes determining that determining that a first distributed mobile



architecture gateway (DMAG) supports communication with the destination device based on registration data stored at the first DMA server. The method also includes converting voice information associated with the call to packet data. The method also includes routing the packet data to the destination device via the DMAG.

In another embodiment, a method includes receiving a call from a communication device at a distributed mobile architecture gateway (DMAG) via a network. The call is associated with a destination device. The method also includes determining that a first distributed mobile architecture (DMA) server supports wireless communication with the destination device based on registration data stored at the DMAG. The method also includes converting information associated with the call to packet data and routing the packet data to the destination device via the first DMA server.

In another embodiment, a computer-readable medium is disclosed. The computer-readable medium includes instructions executable by a processor. The computer-readable medium includes instructions to receive a call from a communication device at a distributed mobile architecture gateway (DMAG). The call is associated with a destination device. The computer-readable medium also includes instructions to determine that a first distributed mobile architecture (DMA) server supports communication with the destination device based on registration data stored at the DMAG. The computer-readable medium also includes instructions to convert information associated with the call to packet data to be routed to the destination device via the first DMA server.

Referring to FIG. **1**, a first embodiment of a system to control wireless communications is illustrated and generally designated **100**. The system **100** includes one or more legacy networks **102** coupled to a distributed mobile architecture gateway (DMAG) **104**. The one or more legacy networks **102** may include one or more wide-area wireless communication networks, one or more landline communication networks, one or more local area networks (LANs), one or more wireless local area networks (WLANs), or any combination thereof. The DMAG **104** may receive one or more types of traffic from the legacy networks **102**. In FIG. **1**, the DMAG **104** receives wireless voice traffic **106**, wireless data traffic **108**, landline voice traffic **110**, landline data traffic **112**, or any combination thereof from the legacy networks **102**. The DMAG **104** routes voice traffic and data traffic between the one or more legacy networks **102** and one or more wireless communication devices via one or more distributed mobile architecture (DMA) servers, such as a first representative DMA server **116**, a second representative DMA server **118**, and a third representative DMA server **120**. In FIG. **1**, the DMAG **104** routes voice traffic and data traffic between the one or more legacy networks **102** and a first representative wireless communication device **122**, a second representative wireless communication device **124**, third representative wireless communication device **126**, and a fourth representative wireless communication device **128**.

The wireless voice traffic **106** may be carried over a Global System for Mobile Communications (GSM) network, a Code Division Multiple Access (CDMA) network, a Time Division Multiple Access (TDMA) network, a Universal Mobile Telecommunications System (UMTS) network, a Personal Communications Service (PCS) network, or any combination thereof. Signaling related to the wireless voice traffic **106** may be carried over a Signaling System 7 (SS7) network and may utilize an American National Standards Institute (ANSI) 41 protocol, a Mobile Application Part (MAP) protocol, or a Customized Application of Mobile Enhanced Logic

(CAMEL) protocol. The wireless data traffic **108** may be carried over a General Packet Radio Service (GPRS) network, an enhanced GPRS (EGPRS) network, an IEEE 802.16 network, a UMTS network, a High Speed Packet Access (HSPA) network, or any combination thereof. The wireless data traffic **108** may be formatted according to Internet Protocol (IP). Additionally, wireless voice traffic may be carried over a wireless data traffic connection **108** using a mobile Voice over Internet Protocol (VoIP) technology.

One or more landline communication networks may carry voice traffic **110**, data traffic **112**, or any combination thereof. The one or more landline communication networks may carry landline voice traffic **110** over a Public Switched Telephone Network (PSTN), an Integrated Services Digital Network (ISDN), or any combination thereof. Signaling related to the landline voice traffic **110** may be carried over an SS7 network and may utilize an Integrated Service Digital Network User Part (ISUP) protocol. The landline data traffic **112** may be carried over a Digital Subscriber Line (DSL) network, an Asynchronous Transfer Mode (ATM) network, an optical fiber network, a coaxial cable network, or any combination thereof. Landline voice traffic may also be carried over a landline data traffic connection **112** using Voice over Internet Protocol (VoIP). The landline data traffic **112** may also be formatted according to Internet Protocol (IP).

The legacy networks **102** communicate the wireless voice traffic **106**, the wireless data traffic **108**, the landline voice traffic **110**, the landline data traffic **112**, or any combination thereof, to the DMAG **104**. The DMAG **104** is adapted to route voice traffic and data traffic between the one or more legacy networks **102** and one or more wireless communication devices, such as the wireless communication devices **122**, **124**, **126** and **128** via a private Internet Protocol (IP) network **114**. The private IP network **114** may include a landline IP network, a wireless IP network, or any combination thereof. For example, the DMAG **104** may route voice traffic and data traffic between the one or more legacy networks **102** and the first wireless communication device **122** and the second wireless communication device **124** via the first DMA server **116**. The DMAG **104** may also route voice traffic and data traffic between the one or more legacy networks **102** and the third wireless communication device **126** via the second DMA server **118**.

Additionally, the DMAG **104** may route voice traffic and data traffic between the wireless communication devices **122-128**. For example, the DMAG **104** may route voice traffic and data traffic between wireless communication devices served by the same DMA server. Further, the DMAG **104** may route voice traffic and data traffic between wireless communication devices served by different DMA servers. In an illustrative example, the DMAG **104** may route voice traffic and data traffic between the third wireless communication device **126** and the fourth wireless communication device **128**.

Each of the DMA servers **116-120** are adapted to route voice traffic, data traffic, or any combination thereof, related to wireless communication devices served by the respective DMA server. For example, the DMA servers **116-120** may be adapted to route voice traffic and data traffic between wireless communication devices served by the same DMA server. To illustrate, the first DMA server **116** may route voice traffic and data traffic between the first wireless communication device **122** and the second wireless communication device **124**. Additionally, the DMA servers **116-120** may be adapted to route voice traffic and data traffic between the wireless communication devices **122-128** served by different DMA servers. For example, the first DMA server **116** and the third DMA server **120** may route voice traffic and data traffic between the first wireless communication device **122** and the third wireless communication device **126**.

Each of the DMA servers **116-120** are adapted to send and receive voice and data traffic using more than one type of wireless protocol. For example, each of the DMA servers **116-120** may send and receive voice and data traffic using a Global System for Mobile (GSM) communications protocol, a Code Division Multiple Access (CDMA) protocol, a Universal Mobile Telephone System (UMTS) protocol, Worldwide Interoperability for Microwave Access (WiMAX) protocol, other wireless protocol, or any combination thereof.

In operation, each of the DMA servers **116-120** sends and receives voice and data traffic between at least two communications devices. When the same DMA server serves the communications devices, then the DMA server may route the call. Routing the call may include terminating the call at a destination communication device. The DMA server can support routing a call between different wireless technologies. For example, the first DMA server **116** may route a call from the first wireless communications device **122** to the second wireless communications device **124**, where the first wireless communications device **122** uses the GSM protocol while the second wireless communications device **122** uses the CDMA protocol.

When two DMA servers serve two wireless communications devices, the call may be routed via an IP network or via a DMAG. In one illustrative embodiment, the first DMA server **116** may route a call originating at the first wireless communications device **122** to the fourth wireless communications device **128** via the IP network **114** and via the third DMA server **120**. When the DMAG **104** services two or more DMA servers, such as the DMA servers **116-120**, calls routed between the DMA servers **116-120** may be routed via the IP network **114** without involving the DMAG **104**. When a call is routed between the DMA servers **116** and **120** and the DMAG **104** is not involved in routing the call, the routing is known as a peer-to-peer routing. In a second illustrative embodiment, the first DMA server **116** may route a call originating at the first wireless communications device **122** via the LP network **114** to the DMAG **104** and the DMAG **104** may route the call via the third DMA server **120** to the fourth wireless communications device **128**. For example, the DMAG **104** may route the call when the DMA server **120** is serviced by a second DMAG (not shown).

The DMA servers **116-120** also send and receive voice and data traffic from the wireless communication devices **122-128** to the legacy networks **102**. For example, a call originating at the first wireless communications device **122** may be routed via the first DMA server **116** to the legacy networks **102** via the IP network **114** and via the DMAG **104**.

In a conventional system, providing wireless access via a specific wireless protocol to wireless communications devices typically requires a base transceiver station (BTS), a base station controller (BSC) and a Mobile Switching Center (MSC). To provide wireless access via more than one wireless protocol typically requires a BTS, a BSC, and an MSC for each wireless protocol. Even when the functionality of the BTS, BSC, and MSC is integrated into a single unit, each unit only provides wireless access via a specific wireless protocol. For example, providing GSM, CDMA, and WiMAX typically requires the use of at least three units, with a first unit providing GSM access, a second unit providing CDMA access, and a third unit providing WiMAX access. In contrast, the system **100** allows a single integrated unit to provide wireless access via more than one wireless protocol. For example, a single integrated unit, such as the first DMA server **116** may provide wireless access via more than one wireless protocol, such as GSM, CDMA, UMTS, and WiMAX. Each of the DMA servers **116-420** can support additional wireless protocols by adding an appropriate transceiver. For example, the first DMA server **116** may provide CDMA evolution data optimized (EVDO) access by adding a transceiver capable of providing CDMA-EVDO.

Referring to FIG. **2**, a second embodiment of a system to control wireless communications is illustrated and generally designated **200**. The system **200** includes distributed mobile architecture gateways (DMAGs) **202**, **204**, and **206**. Each of the DMAGs **202-206** is coupled to one or more legacy networks. For example, the first DMAG **202** is coupled to one or more legacy networks **208**, the second DMAG **204** is coupled to one or more legacy networks **210**, and the third DMAG **206** is coupled to one or more legacy networks **212**. Each of the legacy networks **208-212** may include one or more landline networks, one or more wireless networks, or any combination thereof, to carry voice traffic and/or data traffic to the DMAGs **202-206**. Although the legacy networks **208-212** are shown as separate boxes, the legacy networks **208-212** may include one or more of the same legacy networks. Alternatively, each of the DMAGs **202-208** may serve as a backhaul to different legacy networks. To illustrate, the one or more legacy networks **208** may include legacy landline voice and data networks, the one or more legacy networks **210** may include a particular wireless voice and data network, such as a time division multiple access (TDMA) network, and the one or more legacy networks **212** may include another wireless voice and data network, such as a code division multiple access (CDMA) network.

Each of the DMAGs **202-206** may communicate via a private Internet Protocol (IP) network, such as the private IP networks **214-218**. The DMAGs **202-206** may communicate with each other via the private IP networks **214-218**, with one or more groups of distributed mobile architecture (DMA) servers **220-224**, or any combination thereof. Although the private IP networks **214-218** are shown in FIG. **2** as separate networks, the private IP networks may represent either separate private IP networks or a single private IP network.

In a particular embodiment, the first DMAG **202** controls communications related to the first group of DMA servers **220** via the first private IP network **214**. Additionally, the second DMAG **204** controls communications related to the second group of DMA servers **222** via the second private IP network **216** and the third DMAG **206** control communications related to the third group of DMA servers **224** via the third private IP network **218**. Each of the DMA servers in a respective group of DMA servers may communicate with one or more wireless communication devices (not shown).

Each of the DMAGs **202-206** may control communications related to a respective group of DMA servers by routing voice traffic, data traffic, signaling, or any combination thereof, between the one or more legacy networks **208-212** and one or more wireless communication devices communicating with the respective groups of DMA servers **220-224**. In an illustrative embodiment, the second DMAG **204** is adapted to control communications related to the second group of DMA servers **222**. In FIG. **2**, the second group of DMA servers includes DMA server **230**, DMA server **232**, DMA server **234**, and DMA server **236**. The second DMAG **204** may route voice traffic, data traffic, signaling, or any combination thereof, between the one or more legacy networks **210** and one or more wireless communication devices registered with the DMA servers **230-236** in the second group of DMA servers **222**.

In an illustrative embodiment, each DMAG **202-206** may be specified by a communications service provider as a primary node to control voice traffic, data traffic, signaling, or any combination thereof, for designated DMA servers. For example, the second DMAG **204** may serve as a primary node to control voice traffic, data traffic, signaling, or any combination thereof, related to one or more of the DMA servers of the second group of DMA servers **222**, such as the DMA servers **230-232**. Additionally, the second DMAG **204** may control voice traffic, data traffic, signaling, or any combination thereof, related to one or more of the DMA servers of the second group of DMA servers **222** that have roamed into a coverage area associated with the second DMAG **204**, such as the DMA servers **234-236**.

Each DMA server of a particular group of DMA servers may be specified as a primary node for controlling communications related to one or more designated wireless communication devices. In addition, each DMA server of a particular group of DMA servers may be adapted to control communications related to one or more wireless communication devices that have roamed into a coverage area of a particular DMA server. Wireless communication devices may roam between DMA servers within a particular group of DMA servers and wireless communication devices may roam between DMA servers included in different groups of DMA servers. In one example, when the DMA server **230** serves as a primary node for a particular wireless communication device, the particular wireless communication device can roam from the coverage area of the DMA server **230** to a coverage area of the DMA server **232**. In another example, when the DMA server **230** serves as a primary node for a particular wireless communication device, the particular wireless communication device can roam into a coverage area of a DMA server of the third group of DMA servers **224**.

In an illustrative embodiment, a DMA server, such as the DMA server **230** may move from one group of DMA servers, such as the second group of DMA servers **222**, to another group of DMA servers, while controlling communications related to one or more wireless communication devices in the coverage area of the DMA server **230**. In an example, one or more wireless communications devices in the coverage area of the DMA server **230** when the DMA server **230** is included in the second group of DMA servers **222** may remain within the coverage area of the DMA server **230** by moving along with the DMA server **230** to the third group of DMA servers **224**. Further, as the DMA server **230** moves to the third group of DMA servers **224**, one or more additional wireless communication devices may register with the DMA server **230**. In an illustrative, non-limiting embodiment, the second group of DMA servers **222** may be associated with a coverage area of the second DMAG **204** and the third group of DMA servers **224** may be associated with a coverage area of the third DMAG **206**.

Each particular DMAG **202-206** may be adapted to route communications between wireless communication devices in coverage areas of different DMA servers of the respective group of DMA servers associated with the particular DMAG. Additionally, each DMAG **202-206** may be adapted to route communications between wireless communication devices in the coverage area of the same DMA server of the respective group of DMA servers associated with the particular DMAG. In one example, the second DMAG **204** may be adapted to route voice traffic, data traffic, or any combination thereof, between wireless communication devices in the coverage area of the DMA server **230** and wireless communication devices in the coverage area of the DMA server **232**. In another example, the second DMAG **204** may be adapted to route voice traffic, data traffic, or any combination thereof, between wireless communication devices in the coverage area of the DMA server **230**. Further, the DMAGs **202-206** may be adapted to control communications between wireless communication devices in the coverage area of a DMA server of one group of DMA servers and in the coverage area of another DMA server of a different group of DMA servers. To illustrate, the second DMAG **204** and the third DMAG **206** may be adapted to route voice traffic, data traffic, or any combination thereof, between a wireless communication device in the coverage area of the DMA server **230** and a wireless communication device in the coverage area of a DMA server of the third group of DMA servers **224**.

In addition, each DMA server of a particular group of DMA servers may be adapted to route communications locally between wireless communication devices in the coverage area of the respective DMA server. For example, the DMA server **230** may be adapted to control voice traffic, data traffic, or any combination thereof, related to one or more wireless communication devices in the coverage area of the DMA server **230**. Further, DMA servers included in a particular group of DMA servers may be adapted to route communications between wireless communication devices in the coverage areas of the DMA servers of the same group of DMA servers. To illustrate, the DMA server **230** and the DMA server **232** may be adapted to control voice traffic, data traffic, or any combination thereof, between wireless communication devices in the coverage area of the DMA server **230** and wireless communication devices in the coverage area of the DMA server **232**. Additionally, DMA servers included in different groups of DMA servers may be adapted to route communications between wireless communication devices in coverage areas of the DMA servers included in the different groups. In an example, the DMA server **230** and a particular DMA server of the third group of DMA servers **224** may control voice traffic, data traffic, or any combination thereof, between wireless communication devices in the coverage area of the DMA server **230** and wireless communication devices in the coverage area of the particular DMA server included in the third group of DMA servers **224**.

In the event of a failure of a particular DMAG, one or more DMAGs may control communications that would otherwise be controlled by the failed DMAG. In an illustrative embodiment, in the event of a failure of the second DMAG **204**, the first DMAG **202**, the third DMAG **206**, or any combination thereof, may control communications related to the second group of DMA servers **222**. For example, the first DMAG **202** and the third DMAG **206** may control voice traffic, data traffic, signaling, or any combination thereof, between the one or more legacy networks **210** and the wireless communication devices in the coverage areas the DMA servers **230-236**.

Each of the DMAGs **202-206** may include redundant registration data with respect to each other, in order to assume control of communications in response to a failure in another one of the DMAGs **202-206**. The registration data related to a particular DMAG may be redundantly stored in one or more additional DMAGs. In an illustrative, non-limiting embodiment, redundant registration data related to the second DMAG **204** may be stored at the first DMAG **202** and the third DMAG **206**.

Registration data may identify that a particular DMAG is specified as the primary node to control communications related to certain DMA servers. In addition, registration data may identify a number of DMA servers that are roaming with respect to a particular DMAG. For example, registration data associated with the second DMAG **204** may identify that the second DMAG **204** is the primary node for the DMA servers **230-232** and that the DMA servers **234-236** are roaming with respect to the DMAG **204**. Further, registration data may identify the wireless communication devices that are registered with the DMA servers included in a particular group of DMA servers. To illustrate, registration data associated with the second DMAG **204** may identify that the DMA server **230** is specified to serve as a primary node to control communications related to some wireless communication devices registered with the DMA server **230** and that other wireless communication devices registered with the DMA server **230** are roaming with respect to the DMA server **230**. Registration data related to a particular wireless communication device may include an identifier, such as an international mobile subscriber identification (IMSI), associated with the particular wireless communication device. Additionally, the registration data may include further information related to an account associated with a particular wireless communication device.

Additionally, the DMA servers within a particular group of DMA servers may include redundant registration data needed to route communications in response to a failure of a DMA server in the particular group of DMA servers. In an illustrative embodiment, each DMA server of the second group of DMA servers **222** includes registration data identifying one or more wireless communication devices registered with one or more of the other DMA servers in the second group of DMA servers **222**. For example, the DMA server **230** may include registration data identifying wireless communication devices in the coverage area of the DMA server **230** and registration data identifying wireless communication devices in the coverage area of the DMA server **232** and in the coverage area of the DMA server **234**. Thus, the DMA server **230** can route voice traffic, data traffic, or any combination thereof, of wireless communication devices in the respective coverage areas of the DMA servers **232**, **234**, if the DMA server **232** and/or the DMA server **234** fails. To illustrate, if the DMA server **232** fails, the DMA server **230** can route communications between the second DMAG **204** and the wireless communication devices in the coverage area of the failed DMA server **232**. Additionally, the DMA server **230** can route communications between wireless communication devices in the coverage area of the DMA server **232** at the time of failure. Further, the DMA server **230** can route communications between wireless communication devices in the coverage area of the DMA server **232** and wireless communication devices in the coverage area of other DMA servers of the system **200**.

In some embodiments, a communications service provider may specify that one or more of the DMAGs **202-206** are adapted to route voice traffic, data traffic, and signaling related to wireless communication devices served by a particular group of DMA servers. In other embodiments, a communications service provider may specify that a particular DMAG is adapted to route voice and data traffic related to wireless communications devices served by a particular group of DMA servers, while another DMAG is adapted to handle the signaling related to communications associated with wireless communication devices registered with the particular group of DMA servers. In an example, the first DMAG **202** may be adapted to manage signaling related to communications associated with each group of DMA servers **220-224**, while the second DMAG **204** and the third DMAG **206** are adapted to control voice traffic and data traffic related to communications associated with each group of DMA servers **220-224**.

Referring to FIG. **3**, a third embodiment of a system to control wireless communications is illustrated and is generally designated **300**. The system **300** includes a distributed mobile architecture gateway (DMAG) **302** that communicates with a distributed mobile architecture (DMA) server **304** via a private Internet Protocol (IP) network **306**. The DMAG **302** includes a processor **308**, a memory **310**, and a data network interface **312** coupled to the private IP network **306**. Additionally, the DMAG **302** includes a first network interface **314**, a second network interface **316**, a third network interface **318**, and a fourth network interface **320**.

The first network interface **314** is adapted to communicate with a first legacy network **322**. For example, the first legacy network **322** may be a landline voice network, such as a Public Switched Telephone Network (PSTN), an Integrated Services Digital Network (ISDN), other voice network or any combination thereof. The second network interface **316** is adapted to communicate with a second legacy network **324**. For example, the second legacy network **324** may be a landline data network, such as a Digital Subscriber Line (DSL) network, a cable television network, fiber-optic network, other data network or any combination thereof. The third network interface **318** is adapted to communicate with a third legacy network **326**. For example, the third legacy network **326** may be a wireless voice network, such as a Global System for Mobile Communications (GSM) network, a Code Division Multiple Access (CDMA) network, a Universal Mobile Telecommunications System (UMTS) network, other wireless protocol network, or any combination thereof. The fourth network interface **320** is adapted to communicate with a fourth legacy network **328**. For example, the fourth legacy network **328** may be a wireless data network, such as a General Packet Radio Service (GPRS) network, an IEEE 802.16 network, a UNITS network, an evolution data optimized (EVDO) network, a one times Radio Transmission Technology (1XRTT) network, a High Speed Packet Access (HSPA) network, other data network, or any combination thereof.

Signaling received via the first network interface **314** from the first legacy network **322** may relate to Intelligent Network (IN) signaling, such as Signaling System 7 (SS7), and may include Integrated Services Digital Network User Part (ISUP) signaling, Message Transfer Part (MTP) signaling, Signaling Control Connection Part (SCCP) signaling, Transaction Capabilities Application Part (TCAP) signaling, Telephone User Part (TUP) signaling, Data User Part (DUP), other signaling protocol, or any combination thereof. Further, signaling received via the second network interface **316** from the second legacy network **324** may include session initiation protocol (SIP) signaling, H.323 signaling, or any combination thereof. Additionally, signaling received via the third network interface **318** from the third legacy network **326** may relate to IN signaling and may include mobile application part (MAP) protocol, American National Standards Institute (ANSI) 41 protocol, customized application of mobile enhanced logic (CAMEL), or any combination thereof. Signaling received via the fourth network interface **320** from the fourth legacy network **328** may include SIP signaling.

Although the first legacy network **322** and the second legacy network **324** are shown coupled to separate network interfaces **314** and **316**, respectively, the first legacy network **322** and the second legacy network **324** may utilize the same infrastructure and may be coupled to a single interface. In an illustrative embodiment, the first legacy network **322** and the second legacy network **324** may be related to a telephone company communications network that carries voice traffic via a circuit-switched PSTN and data traffic via a packet switched network. The DMAG **302** may receive voice traffic and the data traffic from the telephone company communications network at a single interface that separates the voice traffic, the data traffic, signaling information, or any combination thereof.

Further, although the third legacy network **326** and the fourth legacy network **328** are shown coupled to separate network interfaces **318**, **320**, respectively, the third legacy network **326** and the fourth legacy network **328** may utilize the same infrastructure and may be coupled to a single interface. In an illustrative embodiment, the third legacy network **326** and the wireless data network may be related to a wireless communications provider network that carries voice traffic via a Global System for Mobile Communications (GSM) network and carries data traffic via a General Packet Radio Service (GPRS) network. The DMAG **302** may receive voice traffic and data traffic from the wireless communications provider network at a single interface that separates the voice traffic, the data traffic, signaling information, or any combination thereof.

The memory **310** includes one or more gateway modules **330**, one or more conversion modules **332**, and a routing module **334**. In one embodiment, each of the modules **330-334** represents instructions that are executable by the processor **308**, such as instructions embodied in one or more software programs stored at the memory **310**. In another embodiment, the modules **330-334** represent hardware, software instructions, firmware instructions, logic instructions, or any combination thereof. The DMAG **302** also includes register data **336**. The register data **336** may be stored at one or more data stores at the DMAG **302**. An example of data stores storing the register data **336** are shown in FIG. **7**. The register data **336** may include information, such as routing information and registration information, related to one or more DMA servers, such as the DMA server **304** that route voice and data traffic via the DMAG **304**. Additionally, the register data **336** may include information related to other DMA servers that are served by other DMAGs. Further, the register data **336** may include information related to wireless communication devices registered with the DMA servers served by the DMAG **302**, such as the wireless communication devices **360**, **362**, **364**, and **366** registered and communicating with the DMA server **304**. The register data **336** may also include information related to wireless communication devices related to other DMA servers served by other DMAGs.

The one or more gateway modules **330** may be adapted to distribute voice traffic, data traffic, signaling, or any combination thereof, communicated via the network interfaces **314-320**. In a particular embodiment, each of the network interfaces **314-320** is associated with a respective gateway module **330**. For example, a first gateway module may be adapted to communicate voice traffic, signaling, or any combination thereof, from the first network interface **314**. The first gateway module may send voice traffic to a corresponding conversion module **332** and send signaling to the routing module **334**. Additionally, a second gateway module may be adapted to communicate voice traffic, data traffic, signaling, or any combination thereof, from the second network interface **316**. The second gateway module may send voice traffic and data traffic to a corresponding conversion module **332** and send signaling to the routing module **334**. Further, a third gateway module may be adapted to communicate voice traffic, signaling, or any combination thereof, from the third network interface **318**. The third gateway module may send the voice traffic to a corresponding conversion module **332** and send signaling to the routing module **334**. The one or more gateway modules **330** may also include a fourth gateway module adapted to communicate voice traffic, data traffic, signaling, or any combination thereof, via the fourth network interface **320**. The fourth gateway module may send voice traffic and data traffic to corresponding conversion modules **332** and send signaling to the routing module **334**. Additionally, the one or more gateway modules **330** may be adapted to communicate voice traffic, data traffic, signaling, or any combination thereof, from the one or more conversion modules **332**, the routing module **334**, or both.

The one or more conversion modules **332** may be adapted to convert voice traffic, data traffic, or any combination thereof, communicated via the network interfaces **314-320** to Internet Protocol (IP) for transmission to a destination wireless communication device via the private IP network **306**.

The representative DMA server **304** includes a processor **340**, a memory **342**, a network interface **344** coupled to the private IP network **306**, and a device register **346**. The memory **342** includes conversion module **348** and routing module **350**. The DMA server **304** also includes representative BTS interfaces **352**, **354**, **356**, and **358**. The BTS interface **354** is adapted to communicate with first and second wireless communication devices **364** and **366** via a representative first base transceiver station (BTS) device **360**. Additionally, the BTS interface **354** is adapted to communicate with wireless communication devices **368** and **370** via a representative second base transceiver station (BTS) device **362**.

The network interface **344** is adapted to transmit data packets to the private IP network **306** and to receive data packets from the private IP network **306**. The device register **346** is adapted to store registration information about the wireless communication devices **364-370** when the wireless communication devices **364-370** first enter the wireless coverage area of the BTS devices **360-362**. The routing module **350** is adapted to route a call originating from or terminating at the wireless communication devices **364-370**. The conversion module **348** is adapted to convert voice information from an originating call to data packets for transmission via the private IP network **306** and the DMAG **302** to the legacy networks **322-328**. The BTS interfaces **352-358** are adapted to control one or more BTS devices. In FIG. **2**, the second BTS interface **354** controls the BTS devices **360-362**. The BTS devices **360-362** communicate signals to the wireless communication devices **364-370** via a wireless protocol, such as CDMA, GSM, and UMTS.

In operation, the DMA server **304** routes a call originating from the wireless communications device **360** via the private IP network **306** to another DMA server (not shown) or to the DMAG **302**. When the first wireless communications device **360** originates a call, the BTS interface **348** notifies the routing module **354** that a call requires routing. The routing module **354** determines a route for the call based on the destination address of the call. The conversion module **350** converts the call information to data packets and sends the data packets via the network interface **344** to the private IP network **306** via the network interface **344**. The private IP network **306** then routes the data packets to another DMA server (not shown) or to the DMAG **302**.

The DMAG **302** communicates the data packets via the data network interface **312**. The conversion module(s) **330** may convert the data packets from one format to another format based on the characteristics of the legacy networks **322-328**. For example, the conversion module **332** may convert the data packets to an analog format when the destination legacy network is a landline voice network. The routing module **334** routes the data packets to one of the legacy networks **322-328** via the network interfaces **314-320**.

When a call originates from one of the legacy networks **322-328**, the call is communicated to one of the network interfaces **314-320**. The conversion module(s) **332** converts the voice or data call to data packets. The routing module **334** determines a route for the data packets based on the destination address of the call and communicates the data packets to the data network interface **312**. The data network interface **312** communicates the packets to the DMA server **304** via the private IP network **306**.

The DMA server **304** receives the data packets from the private IP network **306** via the network interface **306**. The routing module **350** determines which of the BTS devices **360-362** serves the destination wireless communications device. The data packets are communicated to one of the BTS devices **360-362**. For example, when the data packets are destined for wireless communications device **370**, the data packets are communicated via the second BTS interface **352** to the second BTS device **362** and from the second BTS device to the wireless communications device **370**.

Referring to FIG. **4**, a flow diagram is provided to illustrate a first method of controlling wireless communications. The method may be performed by a module at a distributed mobile architecture device, such as the DMA **304** in FIG. **3**. At **402**, a first call is received at a DMA server from a first mobile communication device via a first wireless communication protocol. Moving to **404**, a second call is received at the DMA server from a second mobile communication device via a second wireless communication protocol. The first and second wireless communication protocols may be one or more of the GSM protocol, the CDMA protocol, the UMTS protocol, the WiMAX protocol, other wireless protocol, or any combination thereof. Proceeding to **406**, voice information associated with the first call is converted to first packet data and the voice information associated with the second call is converted to second packet data. The first and second packet data may be in one or more of Frame Relay, Asynchronous Transfer Mode (ATM), IP, other packet format, or any combination thereof. Advancing to **408**, the first packet data and the second packet data are routed via a private Internet Protocol (IP) network to at least one other DMA device, where the first call is accessible to a first destination device and the second call is accessible to a second destination device via the other DMA device (s). In one illustrative embodiment, the other DMA device may include a second DMA server. In a second illustrative embodiment, the other DMA device may include a DMAG. The method ends at **410**.

For example, in FIG. **3**, when the DMA server **304** receives a first call from the first wireless communications device **364** and a second call from the third wireless communications device **368**, the conversion module **348** converts the voice information associated with the first call to first packet data and converts the voice information associated with the second call to second packet data. The routing module **350** routes the first packet data and the second packet data via the private IP network **306** to another DMA device, such as another DMA server or a DMAG.

Referring to FIG. **5**, a flow diagram is provided to illustrate a second method of controlling wireless communications. The method may be performed by a module at a distributed mobile architecture device, such as the DMA **304** in FIG. **3**. At **502**, packet data corresponding to a call at a first digital mobile architecture (DMA) server is received from a second DMA device via a private IP network. Moving to **504**, a destination device for the call is identified and a first wireless communication protocol associated with the destination device is identified. The first DMA server communicates with a plurality of mobile communication devices via a plurality of wireless communication protocols. Continuing to **506**, the packet data associated with the call is converted to voice information. For example, a digital-to-analog converter may be used to convert the packet data to voice information. Advancing to **508**, the voice information is communicated to the destination device via the identified wireless communication protocol. At **510**, if another call is received, then the method repeats steps **504-508**. If at **510**, another call is not received then the method ends at **512**.

For example, in FIG. **1**, when the third DMA server **120** receives packet data corresponding to a call at the first DMA server **116** via the IP network **114**, the third DMA server **120** identifies that the call is destined for the fourth wireless communications device **128**. The third DMA server **120** identifies that the fourth wireless communications device **128** is associated with the UMTS wireless protocol. The third DMA server **120** converts the packet data associated with the call to voice information and communicates the voice information to the fourth wireless communications device **128** via the UMTS wireless protocol.

Referring to FIG. **6**, a flow diagram is provided to illustrate a third method of controlling wireless communications. The method may be performed by a module at a distributed mobile architecture device, such as the DMAG **302** in FIG. **3**. At **602**, a call is received at a distributed mobile architecture gateway (DMAG). At **604**, if the call is from a legacy network, then the method proceeds to **606**. At **606**, the destination device and destination DMA server are identified. Continuing to **608**, voice information from the call is converted to packet data and the packet data is routed to the destination DMA server. Advancing to **622**, if another call is not received, then the method ends at **624**.

At **604**, if the call is not from a legacy network, then the method proceeds to **610**. At **610** a destination device associated with the call is identified. Moving to **612**, if the destination device is associated with a DMA system then the method proceeds to **614**. At **614**, the destination DMA server associated with the destination device is identified. Advancing to **616**, packet data associated with the call is routed to the destination DMA server. Continuing to **622**, if another call is not received, then the method ends at **624**.

At **612**, if the destination device is associated with a legacy network, then the method proceeds to **618**. Continuing to **618** the packet data associated with the call is converted to voice information. Proceeding to **620**, the voice information is communicated to the destination device via the legacy network. Advancing to **622**, if another call is received, then the method proceeds back to **604**. At **622**, if another call is not received, then the method ends at **624**.

For example, in FIG. **3**, when the DMAG **302** receives a call, the gateway module **334** determines whether the call is from one of the legacy networks **322-328** or from the DMA server **304**. When the call is from one of the legacy networks **322-328**, the conversion module(s) **332** convert the voice information to packet data and route the packet data to the DMA server **304** via the private IP network **306**. When the call is from the DMA server **304**, the routing module **334** identifies the destination device associated with the call. If the destination device is associated with one of the legacy networks **322-328**, then the conversion module(s) **332** convert the packet data associated with the call to voice information and communicate the voice information to the destination device via one of the legacy networks **322-328**. If the destination device is associated with the DMA server **304**, then the routing module **334** identifies the DMA server **304** as associated with the destination device and routes the packet data to the destination server **304** via the private **1**P network **306**.

FIG. **7** is an illustrative embodiment of data associated with a DMAG, in accordance with FIG. **2**. More specifically, the table **700** illustrates the different databases of data that may be utilized by the DMAGs of FIG. **2** to provide switching or connection of calls between the legacy networks and the DMA servers of FIG. **2**. The data shown in FIG. **7** may increase or decrease based on the size of the DMA network **200** in FIG. **2**. The table **700** illustrates different databases **708**, **710**, **712**, **714**, **716**, and **718** each including tables for a home DMAG **702**, a second DMAG **704**, and third DMAG **706**, corresponding to DMAG **202**, DMAG **204**, and DMAG **206** in FIG. **2**. The home DMAG **702** is also known as the first DMAG **702**.

The DMA server register database **708** includes a home DMA server register that identifies the DMA servers which are associated with the first DMAG **702**. For example, the DMA server register database **708** may identify the first group of DMA servers **220** as associated with the first DMAG **202**, identify the second group of DMA servers **222** as associated with the second DMAG **204**, and identify the third group of DMA servers **224** as associated with the third DMAG **206**. In an illustrative embodiment, the DMA server register is implemented as a database.

The DMA server HLR database **710** includes the home location register for each of the home DMAG **702**, the second DMAG **704**, and the third DMAG **706**. Each home location register of the DMA server HLR database **710** includes calling information for the home mobile stations that are associated respectively with the DMAGs **702-706**.

The DMA server VLR database **712** includes the visitor location registers for the DMAGs **702-706**. Each visitor location register of the DMA server HLR database **712** includes calling information for the visitor mobile stations that are associated respectively with the home DMAG **702**, the second DMAG **704**, and the third DMAG **706**.

The visitor DMA server register database **714** includes a visitor DMA server register that identifies visitor DMA servers associated with the home DMAG **702**, a visitor DMA server register of the second DMAG **704** identifies visitor DMA servers associated with the second DMAG **704**, and a DMA server register of the third DMAG **706** identifies visitor DMA servers associated with the third DMAG **706**.

The visitor DMA server HLR database **716** includes the home location register for each visitor DMA server of the home DMAG **702**, the second DMAG **704**, and the third DMAG **706**. The home location register includes calling information for the mobile stations of each visitor DMA server that are associated respectively with the first DMAG **702**, the second DMAG **704**, and the third DMAG **706**.

The visitor DMA server VLR database **718** includes a visitor location register for each visitor DMA server of the home DMAG **702**, the second DMAG **704**, and the third DMAG **706**. Each visitor location register includes calling information for the visitor mobile stations of each visitor DMA server that are associated respectively with the home DMAG **702**, the second DMAG **704**, and the third DMAG **706**.

The table **720** illustrates the different databases of data that may be utilized by the DMAGs of FIG. **2** to provide switching or connection of calls between the legacy networks and the DMA servers of FIG. **2**. The table **720** illustrates different databases **728**, **730**, **732**, **734**, **736**, and **738** each including tables for home DMAG **722**, first DMAG **724**, and third DMAG **726**. In table **720**, the home DMAG **722** is the second DMAG.

The DMA server register database **728** includes a home DMA server register that identifies the DMA servers which are associated with the home DMAG **722**. For example, the DMA server register database **728** may identify the first group of DMA servers **220** in FIG. **2** as associated with the first DMAG **202**, identify the second group of DMA servers **222** as associated with the second DMAG **204**, and identify the third group of DMA servers **224** as associated with the third DMAG **206**. In an illustrative embodiment, the DMA server register is implemented as a database.

The DMA server HLR database **730** includes the home location register for each of the DMAGs **722-726**. Each home location register of the DMA server HLR database **730** includes calling information for the home mobile stations that are associated respectively with the DMAGs **722-726**.

The DMA server VLR database **732** includes the visitor location registers for the DMAGs **732-736**. Each visitor location register of the DMA server HLR database **732** includes calling information for the visitor mobile stations that are associated respectively with the home (i.e. second) DMAG **722**, the first DMAG **724**, and the third DMAG **726**.

The visitor DMA server register database **734** includes a visitor DMA server register that identifies visitor DMA servers associated with the first DMAG **722**, a visitor DMA server register of the home DMAG **724** identifies visitor DMA servers associated with the second DMAG **724**, and a DMA server register of the third. DMAG **726** identifies visitor DMA servers associated with the third DMAG **726**.

The visitor DMA server HLR database **736** includes the home location register for each visitor DMA server of the home DMAG **722**, the first DMAG **724**, and the third DMAG **726**. The home location register includes calling information for the mobile stations of each visitor DMA server that are associated respectively with the home DMAG **722**, the first DMAG **724**, and the third DMAG **726**.

The visitor DMA server VLR database **738** includes a visitor location register for each visitor DMA server of the home DMAG **722**, the first DMAG **724**, and the third DMAG **726**. Each visitor location register includes calling information for the visitor mobile stations of each visitor DMA server that are associated respectively with the home DMAG **722**, the first DMAG **724**, and the third DMAG **726**.

With the configuration of structure described above, the present disclosure provides a system and method of controlling communications through use of a flexible telecommunications device, i.e., the DMA server **304** (FIG. **3**), that is distributive and associative, i.e., it can operate stand-alone or seamlessly within an existing cellular or other network. Moreover, the DMA server **304** can be integrated with virtually any third party base station. The DMA server **304** can operate with multiple air interfaces including CDMA IS-95, CDMA 1X, CDMA EVDO, GSM, GPRS, W-CDMA, 802.11 (Wi-fi), 802.16 (Wi-fi), etc. Further, the DMA server **304** can provide integrated prepaid billing, OAMP, network management, and AAA functionality. The DMA server **304** can include a Java based user interface and feature configuration system. Also, the DMA server **304** can provide real time call metering, call detail record (CDR) generation, and real time call provisioning. The DMA server **304** may be implemented in a relatively small footprint and has a relatively low power requirement. Further, the DMA server **304** may be implemented using inexpensive and widely available computer equipment.

With one or more of the deployment configurations described above, the present system provides mobile to landline calls from mobile handsets within a DMA server wireless coverage area. Also, mobile to landline calls can be made from mobile handsets roaming into DMA coverage areas. Mobile to mobile calls can be made from home/roaming handsets to DMA handsets and vice versa. Further, mobile to IP calls and IP to mobile calls can be made from within a DMA server coverage area. IP to IP calls can be made from any DMA handset to any IP phone. Additionally, IP to landline calls and landline to IP calls can be made from a DMA handset to any phone. Further, land-line to mobile calls to DMA handsets can be made.

The systems described above may be adapted to provide various data and telephony features by deploying appropriate software and/or hardware. For example, the systems described above may be adapted to provide call forwarding, call waiting, 3-way calling, caller ID, voice mail, and mobile to mobile SMS service, i.e., text messaging. Further, the systems described above may be adapted to provide broadcast SMS service, mobile to land high-speed IP data (1X or GPRS) service and mobile-to-mobile high speed IP data (1X or GPRS) service. Also, the systems described above may be adapted to provide IP-PBX capability.

Further, one or more of the illustrated systems can provide IP transport between distributed elements, e.g., DMA servers **304** (FIG. **3**). Further, the control logic within the DMA server (FIG. **3**) can be distributed and associated. Associated systems can be redundant, self-healing, self-organizing, and scalable. Distributed systems can be "snap-together," i.e., a DMA server (FIG. **3**) can be linked to a previously deployed DMA server (FIG. **3**) in order to broaden, or otherwise extend coverage. Further, distributed systems can be de-centralized to avoid single points of failure.

The above-disclosed subject matter is to be considered illustrative, and not restrictive, and the appended claims are intended to cover all such modifications, enhancements, and other embodiments, which fall within the true spirit and scope of the present invention. Thus, to the maximum extent allowed by law, the scope of the present invention is to be determined by the broadest permissible interpretation of the following claims and their equivalents, and shall not be restricted or limited by the foregoing detailed description.

What is claimed is:

**1**. A method comprising:

receiving a first call from a first mobile device at a first base transceiver station (BTS) interface of a first distributed mobile architecture (DMA) server, wherein the first call is associated with a destination device;

determining that a first distributed mobile architecture gateway (DMAG) supports communication with the destination device based on registration data stored at the first DMA server, wherein the registration data indicates that the destination device is not within a wireless coverage area associated with the first DMA server, and wherein the first DMAG is communicatively coupled to a plurality of DMA servers including the first DMA server;

converting first voice information associated with the first call to first packet data; and

routing the first packet data to the destination device via the first DMAG.

**2**. The method of claim **1**, further comprising:

receiving a second call from a second mobile device at a second BTS interface of the first DMA server, wherein the second call is associated with a third mobile device;

determining that the first DMA server supports communication with the third mobile device based on the registration data, wherein the registration data indicates that the third mobile device is within the wireless coverage area;

converting second voice information associated with the second call to second packet data; and

routing the second packet data to the third mobile device via a third BTS interface.

3. The method of claim 1, further comprising:

in response to a second DMA failing, receiving a second call from a second mobile device that is associated with the second DMA, wherein the second call is associated with a second destination device;

determining that the first DMAG supports communication with the second destination device based on the registration data, wherein the registration data indicates that the second destination device is not within the wireless coverage area;

converting second voice information associated with the second call to second packet data; and

routing the second packet data to the second destination device via the first DMAG.

4. The method of claim 1, wherein the first call uses a first wireless communication protocol and further comprising:

receiving a second call from a second mobile device at a second BTS interface of the first DMA server, wherein the second call uses a second wireless communication protocol that is different from the first wireless communication protocol, and wherein the second call is associated with the destination device;

converting second voice information associated with the second call to second packet data; and

routing the second packet data to the destination device via the first DMAG.

5. The method of claim 4, wherein the first wireless communication protocol is a Universal Mobile Telecommunications System protocol, and wherein the second wireless communication protocol is a Worldwide Interoperability for Microwave Access protocol.

6. The method of claim 1, wherein the first DMAG is in communication with a plurality of legacy communication networks.

7. The method of claim 1, wherein the first DMA server is configured to receive one or more calls while the first DMA server is moving.

8. The method of claim 7, wherein the first DMA server is located within a first coverage area associated with the first DMAG when the first call is received.

9. The method of claim 8, further comprising:

converting additional voice information associated with the call to additional packet data;

in response to determining that the first DMA server has moved into a second coverage area associated with a second DMAG, determining that the second DMAG supports communication with the destination device; and

routing the additional packet data to the destination device via the second DMAG.

10. A method, comprising:

receiving a call from a communication device at a distributed mobile architecture gateway (DMAG) via a network, wherein the call is associated with a destination device, wherein the call is routed to the DMAG from a first distributed mobile architecture (DMA) server in response to the first DMA server determining that the DMAG supports communication with the destination device based on first registration data stored at the first DMA server, wherein the first registration data indicates that the destination device is not within a first wireless coverage area associated with the first DMA server;

determining that a second DMA server supports wireless communication with the destination device based on second registration data stored at the DMAG, wherein the DMAG is communicatively coupled to a plurality of DMA servers including the first DMA server and the second DMA server;

converting information associated with the call to packet data; and

routing the packet data to the destination device via the second DMA server.

11. The method of claim 10, further comprising:

in response to a second DMAG failing, receiving a second call from a second communication device, wherein the second call is associated with a second destination device, and wherein the second communication device is associated with the second DMAG;

determining that a third DMA supports wireless communication with the second destination device based on the second registration data;

converting second voice information associated with the second call to second packet data; and

routing the second packet data to the second destination device via the first DMAG.

12. The method of claim 10, wherein the second registration data indicates that the DMAG is a node that controls communications related to the first DMA server and that a second DMAG controls communications related to a third DMA server.

13. The method of claim 10, wherein the second registration data stored at the DMAG indicates that the second DMA server is associated with a second wireless coverage area, and wherein the second registration data indicates that the destination device is within the second wireless coverage area.

14. The method of claim 13, further comprising:

in response to determining that the destination device has moved from the second wireless coverage area into a third wireless coverage area associated with a third DMA server, determining that the third DMA server supports communication with the destination device based on the second registration data stored at the DMAG; and

routing additional packet data to the destination device via the third DMA server.

15. A non-transitory computer-readable storage medium, comprising instructions, that when executed by a processor, cause the processor to:

receive a call from a communication device at a distributed mobile architecture gateway (DMAG) via a network, wherein the call is associated with a destination device, wherein the call is routed to the DMAG from a first distributed mobile architecture (DMA) server in response to the first DMA server determining that the DMAG supports communication with the destination device based on first registration data stored at the first DMA server, wherein the first registration data indicates that the destination device is not within a first wireless coverage area associated with the first DMA server;

determine that a second DMA server supports communication with the destination device based on second registration data stored at the DMAG, wherein the DMAG is communicatively coupled to a plurality of DMA servers including the first DMA server and the second DMA server; and

convert information associated with the call to packet data to be routed to the destination device via the second DMA server.

16. The non-transitory computer-readable storage medium of claim 15, wherein the instructions further cause the processor to receive a second call at the DMAG from a third DMA server, wherein the call uses a first wireless communi-

cation protocol, and wherein the second call uses a second wireless communication protocol that is different from the first wireless communication protocol.

**17**. The non-transitory computer-readable storage medium of claim **16**, wherein the instructions further cause the processor to determine that a legacy network supports communication with a second destination device associated with the second call based on the second registration data.

**18**. The non-transitory computer-readable storage medium of claim **17**, wherein-the instructions further cause the processor to convert second information associated with the second call to second packet data to be routed to the second destination device via the legacy network.

**19**. The non-transitory computer-readable storage medium of claim **15**, wherein the DMAG supports communication with the network via a first network interface.

**20**. The non-transitory computer-readable storage medium of claim **19**, wherein the DMAG supports communication with at least one additional network via at least one additional network interface.

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